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MOTOR
[Dendoki]

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Specifications

1. Title of the Invention

MOTOR

2. Claims

(1) A direct current-type motor wherein a permanent magnetic rotor rotates due to the rotating magnetic field of the field coils of a stator; said motor characterized by the aforesaid permanent magnetic rotor having at least two driving field poles opposite of and equal to each other at the end faces thereof; composing permanent magnetic bodies provided as counter electrodes due to the same NS magnetic pole at both end faces, and a magnetic substance that rotates mutually and integrally with said permanent magnetic body on its rotating shaft and is arranged concentrically from both end faces of the permanent magnetic bodies via axial gaps; the aforesaid field coils surrounding the driving field poles which are present at both end faces of the aforesaid permanent magnetic bodies and are composed of a plurality of annular coils arranged in the gaps between the aforesaid permanent magnetic bodies and the magnetic substance.

(2) The motor of Claim (1) characterized by the aforesaid permanent magnetic rotor being composed of a pair of permanent magnetic bodies with the same NS magnetic poles arranged concentrically and opposite of each other on the rotating shaft, a 1st magnetic substance which rotates mutually and integrally with these permanent magnetic bodies and is sandwiched between and fixed by the

end faces of the opposing permanent magnetic bodies, and a 2nd magnetic substance arranged opposite both end faces on the other side of the aforesaid permanent magnetic body via axial gaps.

3. Detailed Specifications

The present invention relates to a direct current-type motor so that a rotor having a permanent magnet rotates due to the rotating field of the field coil of a stator.

This kind of conventional motor is shown in Figure 1 and will be explained. In Figure 1, the permanent magnetic rotor is comprised by having a permanent magnetic body **1** in which a plurality of driving field poles facing each other and equal to each other are magnetized at one end face, and driving field poles also are magnetized at the other end face in reverse to the first end face. This rotor is fixed to a nonmagnetic or plastic support **3** which supported rotatably by a rotating shaft **2**. The above-mentioned support **3** is pressed into the rotating shaft **2** or fixed to it with an adhesive. The rotating shaft **2** is supported removably to rotate freely by a bearing **5** arranged in the center portion of a housing **4**.

Meanwhile, field coils **10a** and **10b** constituting a stator are arranged opposite of each other in the axial direction by forming a slight gap between a magnetic plate **7**, which is fixed to the inferior surface of a flange **6** comprising a nonmagnetic substance, and the permanent magnetic body **1** on a magnetic plate **8** fixed to the surface of the bottom of the housing **4** and via respective insulation

substrates **9a** and **9b**. As shown in Figure 2 typically by **10a**, these field coils **10a** and **10b** comprise fan-shaped annular coils having a center angle **α** equal to the angle width of the NS magnetic pole of the permanent magnetic body **1** and are arranged torically on the inferior surface of the insulation substrate **9a** and the top of the substrate **9b** at an arrangement pitch **β** of 360°/(number of coils). Moreover, a well-known magnetic conversion element (not shown), such as a Hall element, is arranged on a lower insulation substrate **9b** for detecting the rotation position of the permanent magnetic rotor.

The upper and lower magnetic substances **7** and **8** to which plurality of field coils **10a** and **10b** are fixed are arranged opposingly with a slight gap between them and the permanent magnetic body **1** via insulation plates **9a** and **9b**; hence, even when a silicon copper plate or the like having a little hysteresis loss or eddy current loss is used, there was a drawback in the motor constituted as above because these losses did not decrease that much. In addition, as seen from Figure 2, the inner and outer peripheral sections of the field coils **10a'** and **10b** did not contribute to generating torque in a conventional motor. Therefore, in order to improve the efficiency of a motor, it was necessary to increase the size of the radial direction parts of the field coils **10a'** and **10b** as well as the ratio of these inner and outer peripheral sections as much as possible. But there was a problem with this because the copper length of the field coils

increased and so did the resistance.

The present invention removes the above-mentioned drawback and problem. The present invention will now be explained on the basis of illustrated practical examples.

Figures 3 and 4 are a plan view and cross section showing a practical example of the present invention. In these drawings, the permanent magnetic rotor has a plurality of driving field poles at one end face and at the other end face; it is comprised by containing a toric permanent magnetic body **11** in which the same NS magnetic poles are corresponded to both end faces, and plate-shaped magnetic substances **13** and **14** which are arranged so that they concentrically face a rotating shaft **12** through axial gaps from both end faces of this permanent magnetic body **11**. This permanent magnetic body **11** and these magnetic substances **13** and **14** are pressed into or fixed, with an adhesive, to the rotating shaft **12** so that they rotate integrally. The rotating shaft **12** is supported rotatably to freely rotate by bearings **16** and **17** provided in the center of a housing **15** comprising a nonmagnetic substance, such as aluminum.

The driving field poles with an N pole and S pole at one end face of the above-mentioned permanent magnetic body **11** are magnetized alternately in equal intervals, as shown in Figs. 3 and 4, and the same driving field poles at the other end face also are magnetized. These driving field poles are composed of at least two NS poles.

Meanwhile, the field coils constituting a stator comprise a

plurality of flat annular coils **18**, and are arranged in a non-contact state with them in the gaps between the permanent magnetic body **11** and the magnetic substances **13** and **14** in a curved shape on the periphery of the above-mentioned permanent magnetic body **11**. Those plurality of annular coils **18** are installed in prescribed positions of the ring-shaped substrate **19** comprising a nonmagnetic substance and fixed on the inside wall of the housing **15**.

In addition, a plurality of Hall elements (not shown) for detecting the position of the permanent magnetic rotor are provided in a part facing the permanent magnetic body **11** of the above-mentioned substrate **19**. These elements output a Hall voltage by the action of the field of the permanent magnetic body **11** so that the power control system of each phase of a well-known proper motor driving circuit.

Figure 5 is a perspective view of the main part of the practical example shown in Figs. 3 and 4. In this practical example, as shown as a front view and side view in Figures 6(a) and (b), annular coils **18** with a hexagonal design and having an angle **α** are arranged in the gaps between the magnetic body and the magnetic substances **13** and **14** by bending it to the periphery the periphery of the permanent magnetic body **11**. These annular coils **18** are wound around the permanent magnetic body **11** in the shape shown in Fig. 6(a) by means of a suitable jig so that the same magnetized driving field poles encircle the entire circumference of the magnetic body, and after molding they

are bent across X-X′ and Y-Y′. Here, the mutually opposing angles **α** of the annular coils **18** shown in Fig. 6(a) are equal to half the angles of the NS poles of the coils **18**, and the arrangement pitch **β** of the annular coils **18** arranged in the gaps between the magnetic substances **13** and **14** and the permanent magnetic body **11** is 360°/n if the number of annular coils **18** is **n**.

Figure 7 is a cross section showing another practical example of the present invention. In this drawing, the permanent magnetic rotor is composed of a pair of permanent magnetic bodies **20a** and **20b** in which the NS magnetic poles are arranged to mutually face the rotating shaft **12** concentrically, a disk-shaped magnetic substance **21** that rotates integrally with that pair of permanent magnetic bodies **20a** and **20b** and is fixed between the end faces of the opposing permanent magnetic bodies **20a** and **20b**, and disk-shaped magnetic substances **13** and **14** arranged concentrically opposite the other end faces of the aforesaid permanent magnetic bodies **20a** and **20b** through gaps in the axial direction.

Meanwhile, so that the magnetized NS magnetic poles encircle both end faces at the other end of the above-mentioned permanent magnetic bodies **20a** and **20b**, the field coils are composed of a plurality of annular coils **18** bent around their peripheral edges. These are arranged in the gaps between the above-mentioned permanent magnetic bodies **20a** and **20b** and the magnetic substances **13** and **14**.

As seen from each of the above practical examples, the motor of the present invention is a motor in which the permanent magnetic rotor rotates due to the rotating effect of the field coils of the stator. It has a structure wherein the permanent magnetic bodies and magnetic substances of the above-mentioned permanent magnetic rotor rotate integrally with each other so that the above-mentioned field coils are arranged in the gaps between the permanent magnetic bodies and the magnetic substances; hence, in comparison to a motor having a structure in which the magnetic substances fixed to the housing and flange and the permanent magnetic bodies, which are permanent magnetic rotors, rotate relative to each other, as with a conventional motor, the hysteresis loss and eddy current loss of the magnetic substance are reduced when the permanent magnetic rotor rotates at high speed, and it is possible to increase efficiency. Furthermore, as in the previously mentioned practical examples of the present invention, the titled motor is composed of a plurality of annular coils in which the above-mentioned field coils surround the same NS magnetic poles at both end faces of the permanent magnetic bodies and are arranged bent around the peripheral edges of the permanent magnetic bodies; hence, the above-mentioned permanent magnetic bodies are extremely flat, and when the thickness thereof is smaller than the pitch of one magnetic pole shown by L/m (provided that **L** is the length of the outer circumference of the permanent magnetic body and **m** is the number of magnetic poles), the outer peripheral portions of the field coils of

the present invention can be made shorter than the outer peripheral portions of the field magnetic coils of a conventional motor; hence, an improvement in efficiency is possible.

Moreover, in the conventional type shown in Fig. 2, the inner and outer peripheral portions of the field coils do not contribute to generating torque. In order to increase efficiency, whereas it is necessary to increase the ratio of the radial direction part thereof and the inner and outer peripheral parts thereof as much as possible, as seen from Figure 4 in the present invention, the magnetic flux on the outer peripheral faces of the permanent magnetic bodies becomes a factor for generating torque in the same direction as the radial direction parts of the coils even in field coils, and the only parts that are ineffective in contributing to the generation of torque are the inner peripheral parts of the field coils; hence, there is a merit because it is possible to remarkably increase efficiency.

4. Brief Description of the Figures

Figure 1 is a cross section of an example of a conventional motor; Figure 2 is a plan view of the main part showing the positional relationship between the permanent magnetic rotor thereof and the field coils; Figure 3 is a plane view of a practical example of the present invention; Figure 4 is a cross section of the same practical example; Figure 5 is a perspective view of the main part of the same practical example; Figures 6(a) and (b) are a front view and side view in front of the bends of the annular coils used in the same practical

example; and Figure 7 is a cross section of another practical example of the present invention.

11: permanent magnetic body; 12: rotating shaft; 13, 14: magnetic substances; 15: housing; 16, 17: bearings; 18: annular coil; 19: substrate; 20, 20a, 20b; permanent magnetic bodies; 21: magnetic substance.